# Light-Duty Automotive Technology and Fuel Economy Trends: 1975 through 2007

## Executive Summary

United States
Environmental Protection
Agency

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Compliance and Innovative Strategies Division
and
Transportation and Climate Division

Office of Transportation and Air Quality
U.S. Environmental Protection Agency

*NOTICE*

*This technical report does not necessarily represent final EPA decisions or positions. It is intended to present technical analysis of issues using data that are currently available. The purpose in the release of such reports is to facilitate the exchange of technical information and to inform the public of technical developments.*

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## I. Executive Summary

### Introduction

This report summarizes key trends in fuel economy and technology usage related to model year (MY) 1975 through 2007 light-duty vehicles sold in the United States. Light-duty vehicles are those vehicles that EPA classifies as cars or light-duty trucks (sport utility vehicles, vans, and pickup trucks with less than 8500 pounds gross vehicle weight ratings).

Since 1975, overall new light-duty vehicle fuel economy has moved through four phases:

1. a rapid increase from 1975 through the early 1980s,
2. a slower increase until reaching its peak in 1987,
3. a gradual decline until 2004, and
4. an increase in 2005 and 2006, with 2007 levels projected to be similar to 2006.

The projected average MY2007 light-duty vehicle fuel economy, based in large part on pre-model year sales projections from automakers, is 20.2 miles per gallon (mpg). The MY2006 value is also 20.2 mpg. There is greater confidence in the MY2006 value as the database for 2006 includes formal sales data for about 70% of the MY2006 fleet. The 20.2 mpg value for model years 2006 and 2007 represents a 0.9 mpg, or 5%, increase over the 19.3 mpg value for 2004, which was the lowest fuel economy value since 1980.

The fuel economy values in this report are either *adjusted* (ADJ) EPA "real-world" estimates provided to consumers, or unadjusted EPA *laboratory* (LAB) values. Most of the data is presented in adjusted values. Either adjusted or laboratory fuel economy may be reported as city, highway, or, most commonly, as *composite* (combined city/highway, or COMP). In 2006, EPA revised the methodology by which EPA estimates adjusted fuel economy to better reflect changes in driving habits and other factors that affect fuel economy such as higher highway speeds, more aggressive driving, and greater use of air conditioning. This is the first report in this series to reflect this new real-world fuel economy methodology, and every adjusted fuel economy value in this report for 1986 and later model years is lower than previously reported. To reflect the fact that these changes did not occur overnight, these new downward adjustments are phased in, gradually, beginning in 1986, and for 2005 and later model years the new adjusted composite (combined city/highway) values are, on average, about 6% lower than under the methodology used by EPA in previous reports in this series. See Appendix A for more details.

Because the underlying methodology for generating unadjusted laboratory fuel economy values has not changed since this series began in the mid-1970s, they provide an excellent basis for comparing long-term fuel economy trends from the perspective of vehicle design, apart from the factors that affect real-world fuel economy that are reflected in the adjusted fuel economy values. For 2005 and later model years, unadjusted laboratory composite fuel economy values are, on average, about 25% greater than adjusted composite fuel economy values.

The Department of Transportation's National Highway Traffic Safety Administration (NHTSA) has the overall responsibility for the Corporate Average Fuel Economy (CAFE) program. For 2007, the CAFE standards are 27.5 mpg for cars and 22.2 mpg for light trucks. EPA provides laboratory composite 55/45 fuel economy data, along with alternative fuel vehicle credits and test procedure adjustments, to NHTSA for CAFE enforcement. Accordingly, current NHTSA CAFE values are a minimum of 25% higher than EPA adjusted fuel economy values.

## Importance of Fuel Economy

Fuel economy continues to be a major area of public and policy interest for several reasons, including:

1. Fuel economy is directly related to energy security because light-duty vehicles account for approximately 40 percent of all U.S. oil consumption, and much of this oil is imported.

2. Fuel economy is directly related to the cost of fueling a vehicle and is of great interest when crude oil and gasoline prices rise.

3. Fuel economy is directly related to emissions of greenhouse gases (i.e., carbon dioxide). Light-duty vehicles contribute about 20 percent of all U.S. carbon dioxide emissions.

### Characteristics of Light Duty Vehicles for Four Model Years

| | 1975 | 1987 | 1997 | 2007 |
|---|---|---|---|---|
| Adjusted Fuel Economy (mpg) | 13.1 | 22.0 | 20.1 | 20.2 |
| Weight (lbs.) | 4060 | 3221 | 3727 | 4144 |
| Horsepower | 137 | 118 | 169 | 223 |
| 0 to 60 Time (sec.) | 14.1 | 13.1 | 11.0 | 9.6 |
| Percent Truck Sales | 19% | 28% | 42% | 49% |
| Percent Front-Wheel Drive | 5% | 58% | 56% | 51% |
| Percent Four-Wheel Drive | 3% | 10% | 19% | 28% |
| Percent Multi-Valve Engine | - | - | 40% | 70% |
| Percent Variable Valve Timing | - | - | - | 59% |
| Percent Cylinder Deactivation | - | - | - | 8% |
| Percent Turbocharger | - | - | 0.5% | 3% |
| Percent Manual Transmission | 23% | 29% | 14% | 8% |
| Percent Continuously Variable Trans | - | - | - | 7% |
| Percent Hybrid | - | - | - | 2.2% |
| Percent Diesel | 0.2% | 0.3% | 0.1% | 0.1% |

**Highlight #1: Fuel Economy Increases in 2005 and 2006 Reverse the Long-Term Trend of Declining Fuel Economy From 1987 Through 2004.**

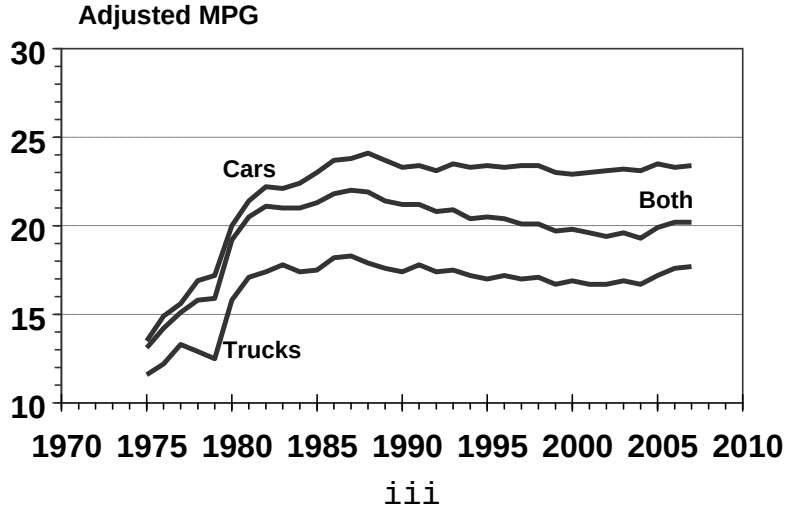
*Overall fuel economy increased 0.9 mpg, or 5%, from 19.3 mpg in MY2004 to 20.2 mpg in MY2006. Fuel economy for both cars and trucks is projected to increase for MY2007. However, due to a slight increase in projected truck market share, the overall value for MY2007 is also projected to be 20.2 mpg. The increases in 2005 and 2006 are the first consecutive annual increases in fuel economy since the mid-1980s. This reverses a long trend of slowly declining fuel economy since the 1987 peak.*

Since 1975, the fuel economy of the combined car and light truck fleet has moved through several phases: (1) a rapid increase from 1975 to the early 1980s, (2) a slow increase extending to the fuel economy peak of 22.0 mpg in 1987, (3) a gradual decline from the peak to 19.3 mpg in 2004, and (4) consecutive annual increases in 2005 and 2006, growing to 20.2 mpg in 2006, with the same value projected for 2007.

The 20.2 mpg value for model years 2006 and 2007 is 1.8 mpg below the peak of 22.0 mpg in MY1987. But, it is important to note that two-thirds of this difference is due to the new methodology for calculating adjusted fuel economy values that is gradually phased in over the 1986 to 2005 timeframe. Based on the laboratory composite 55/45 fuel economy values, which are not affected by the new methodology for calculating adjusted fuel economy values, the MY2006 and MY2007 value of 25.3 mpg is 0.6 mpg below the peak of 25.9 mpg in 1987.

MY2007 cars are projected to average 23.4 mpg and MY2007 light trucks are estimated to average 17.7 mpg, both 0.1 mpg higher than MY2006. Most of the increase in overall fuel economy since 2004 has been due to higher truck fuel economy, as truck fuel economy has increased by 1.0 mpg since 2004 while car fuel economy has increased by 0.3 mpg (prior to MY2007, the overall fleetwide fuel economy increase had also been aided by a slightly higher car market share). The recent increase in truck fuel economy is due, in part, to higher truck CAFE standards, which have risen from 20.7 mpg in 2004 to 22.2 mpg in 2007.

**Adjusted Fuel Economy by Model Year**
**(Annual Data)**

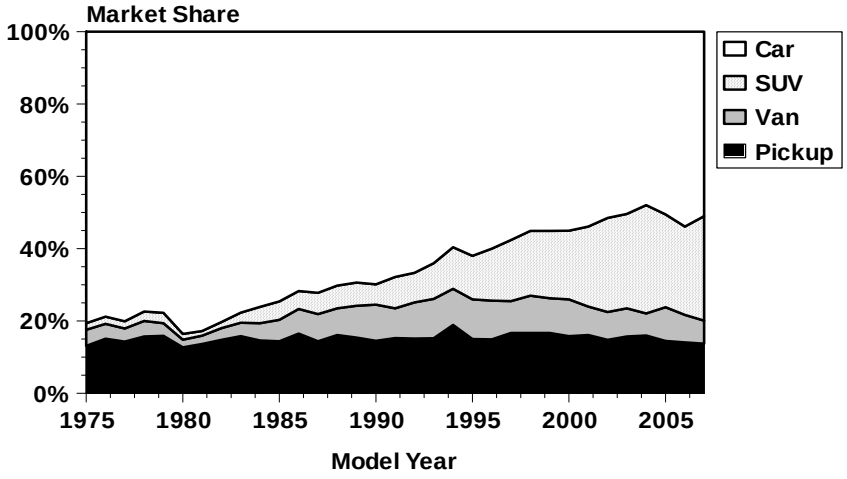


**Highlight #2: Trucks Continue To Represent About Half of New Vehicle Sales.**

*Sales of light trucks, which include sport utility vehicles (SUVs), vans, and pickup trucks, have accounted for about 50 percent of the U.S. light-duty vehicle market since MY2002. After two decades of constant growth, light truck market share has been relatively stable for the last six years.*

Historically, growth in the light truck market was primarily driven by the explosive increase in the market share of SUVs. The SUV market share increased from less than 10 percent of the overall new light-duty vehicle market in MY1990 to about 30 percent of vehicles built each year since 2003. By comparison, market shares for both vans and pickup trucks have declined slightly since 1990. The increased overall market share of light trucks, which in recent years have averaged 5-7 mpg lower than cars, accounted for much of the decline in fuel economy of the overall new light-duty vehicle fleet from MY1987 through MY2004.

**Sales Fraction by Vehicle Type**
**(Annual Data)**

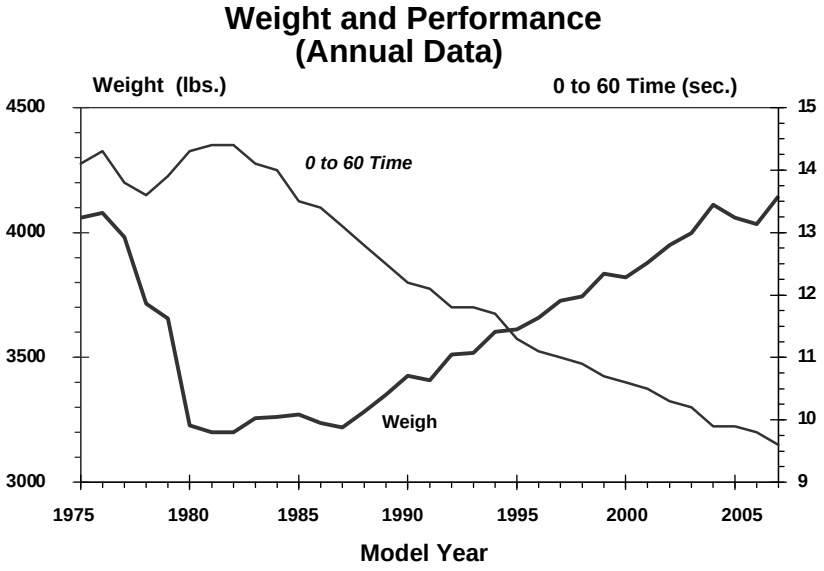


**Highlight #3: Technological Innovation in 2005 and 2006 Was Utilized for Higher Fuel Economy, Reversing the Long-Term Trend of Increasing Vehicle Attributes Such as Weight and Performance.**

*Automotive engineers are constantly developing more advanced and efficient vehicle technologies. From 1987 through 2004, on a fleetwide basis, this technology innovation was utilized to support market-driven attributes other than fuel economy, such as vehicle weight (which supports vehicle content and features), performance, and utility. This long-term trend was reversed in model years 2005 and 2006, as technology was used to increase fuel economy by 0.9 mpg. The current projection for MY2007 is an increase in market-driven attributes with no change in fuel economy, but this is subject to change when EPA obtains formal 2007 sales data.*

Vehicle weight and performance are two of the most important engineering parameters that determine a vehicle's fuel economy. All other factors being equal, higher vehicle weight (which supports new options and features) and faster acceleration performance (e.g., lower 0-to-60 mile-per-hour acceleration time), both decrease a vehicle's fuel economy. Average vehicle weight and performance had increased steadily from the mid-1980s through 2004.

Average light-duty vehicle weight dropped in both model years 2005 and 2006, with a slight increase in weight of cars more than offset by a larger decrease in truck weight and a decrease in truck market share. Average weight is projected to grow again in MY2007 to the highest level ever. Average fleetwide performance was essentially unchanged in both 2005 and 2006, but is also projected to increase to record levels in MY2007. The validity of these projections will be confirmed when EPA obtains formal vehicle sales data after the end of MY2007.



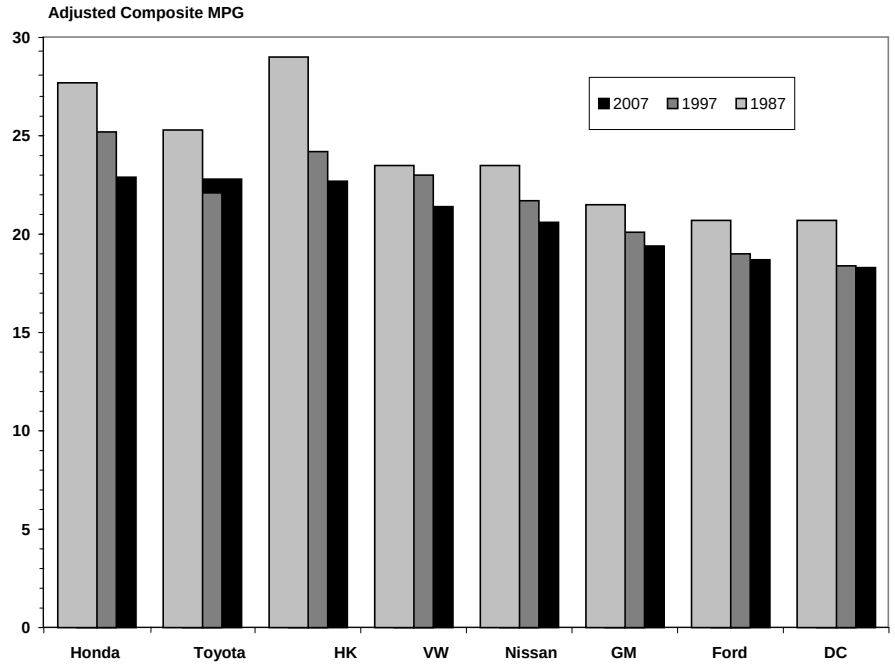
**Highlight #4: Differences Between Marketing Group Fuel Economies are Narrowing.**

*In 1987, when industry-wide fuel economy peaked, some major marketing groups had average fuel economies 6 to 8 mpg higher than other top marketing groups. For MY2007, the maximum difference between major marketing groups is estimated to be 4.6 mpg, with a typical difference between higher and lower fuel economy marketing groups being 3 to 4 mpg.*

For MY2007, the eight highest-selling marketing groups (that account for over 95 percent of all sales) fall into three fuel economy groupings: Honda, Toyota, and Hyundai-Kia (HK) have estimated fuel economies of 22.7 to 22.9 mpg; Volkswagen and Nissan have projected fuel economies of 20.6 to 21.4 mpg; and General Motors, Ford, and DaimlerChrysler have estimated fuel economies of 18.3 to 19.4 mpg. Note that these adjusted fuel economy values for marketing groups can not be directly compared to those in last year's report, since this year's report uses the new methodology where adjusted fuel economy values since 2005 are, on average, about 6% lower than in previous reports.

Each of these marketing groups has lower average fuel economy today than in 1987. Since then, the differences between marketing group fuel economies have narrowed considerably, with some of the higher mpg marketing groups in 1987 showing larger fuel economy decreases since 1987. Only one marketing group, Toyota, shows a slight increase in average fuel economy since 1997. For MY2007, Volkswagen is the only one of the eight highest-selling marketing groups to have a truck market share of less than 40 percent.

**Marketing Group Fuel Economy for Three Model Years**



**Important Notes With Respect to the Data Used in This Report**

Most of the fuel economy values in this report are a single *adjusted* composite (combined city/highway) fuel economy value, based on the real-world estimates for city and highway fuel economy provided to consumers on new vehicle labels, in the EPA/DOE *Fuel Economy Guide*, and in EPA's *Green Vehicle Guide*.

It is important to note that EPA revised the methodology for estimating real-world fuel economy values in December 2006. This is the first report in this series to reflect this new real-world fuel economy methodology, and every adjusted (ADJ) fuel economy value in this report for 1986 and later model years is lower than given in previous reports in this series. Accordingly, adjusted fuel economy values for 1986 and later model years should not be compared with the corresponding values from previous reports. These new downward adjustments are phased in, linearly, beginning in 1986, and for 2005 and later model years the new adjusted composite (combined city/highway) values are, on average, about 6% lower than under the methodology previously used by EPA. See Appendix A for more in-depth discussion of this new methodology and how it affects both the adjusted fuel economy values for individual models and the historical fuel economy trends database.

In some tables and figures in this report, a single *laboratory* composite (combined city/highway) 55/45 value is also shown. Because the underlying methodology for generating and reporting laboratory fuel economy values has not changed since this series began in the mid-1970s, these laboratory fuel economy values provide an excellent basis for comparing long-term fuel economy trends from the perspective of vehicle design, apart from the factors that affect real-world fuel economy that are reflected in the adjusted fuel economy values. For 2005 and later model years, laboratory composite fuel economy values are, on average, about 25% greater than adjusted composite fuel economy values.

Formal Corporate Average Fuel Economy (CAFE) compliance data as reported by the Department of Transportation's National Highway Traffic Safety Administration (NHTSA) does not correlate precisely with either the adjusted or laboratory fuel economy values in this report. While EPA's laboratory composite 55/45 fuel economy data forms the cornerstone of the CAFE compliance database, NHTSA must also include credits for alternative fuel vehicles and test procedure adjustments (for cars only) in the official CAFE calculations. Accordingly, NHTSA CAFE values are at least 25% higher than EPA adjusted fuel economy values for model years 2005 through 2007.

In general, car/truck classifications in this database parallel classifications made by NHTSA for CAFE purposes and EPA for vehicle emissions standards. However, this report relies on engineering judgment, and typically there are a few cases each model year where the methodology used for classifying vehicles for this report results in differences in the determination of whether a given vehicle is classified as a car or a light truck. See Appendix A for a list of these exceptions.

The data presented in this report were tabulated on a model year basis, but many of the figures in this report use three-year moving averages that effectively smooth the trends, and these three-year moving averages are tabulated at the midpoint. For example, the midpoint for model years 2005, 2006, and 2007 is MY2006. Figures are based on annual data unless otherwise noted.

All average fuel economy values were calculated using harmonic, rather than arithmetical, averaging, in order to maintain mathematical integrity. See Appendix A.

The EPA fuel economy database used to generate the fuel economy trends database in this report was frozen in February 2007, yielding additional data beyond that used in last year's report for model years 2004 through 2007, although additional data for MY2006 was added in April 2007.

Through MY2005, the fuel economy, vehicle characteristics, and sales data used for this report were from the formal end-of-year submissions from automakers obtained from EPA's fuel economy database that is used for CAFE compliance purposes. Accordingly, values for all model years up to 2005 can be considered final.

For MY2006, the data used in this report is based on a database where about 70% of the total sales are from formal end-of-year CAFE submissions by automakers, and about 30% are from confidential pre-model year sales projections submitted to the Agency by the automakers, with these latter projections updated based on actual 2006 sales data reported in trade publications. EPA has a high level of confidence in the data for MY2006, given that 70% of the 2006 data is based on actual CAFE reports. It is noteworthy that the 25.3 mpg laboratory fuel economy value for MY2006 in this report is 0.7 mpg higher than the projected 24.6 mpg laboratory fuel economy value for MY2006 in the 2006 report. This suggests that sustained, higher gasoline prices have led to actual 2006 sales that differ from the projected 2006 sales provided to EPA by automakers in 2005.

For MY2007, EPA has exclusively used confidential pre-model year sales projections, updated based on actual sales for the first 7 months of model year 2007 (October 2006 through April 2007). MY2007 projections are more uncertain, particularly given the changes in the automotive marketplace driven by higher fuel prices and other factors. For model years 1998 through 2005, the final laboratory fuel economy values for a given model year have varied from 0.4 mpg lower to 0.3 mpg higher compared to original estimates for the same model year that were based exclusively on projected sales.

**For More Information**

*Light-Duty Automotive Technology and Fuel Economy Trends: 1975 through 2007* (EPA420-R-07-008) is available on the Office of Transportation and Air Quality's (OTAQ) Web site at:

http://www.epa.gov/otaq/fetrends.htm

Printed copies are available from the OTAQ library at:

U.S. Environmental Protection Agency
Office of Transportation and Air Quality Library
2000 Traverwood Drive
Ann Arbor, MI 48105
(734) 214-4311

A copy of the *Fuel Economy Guide* giving city and highway fuel economy data for individual models is available at:

http://www.fueleconomy.gov

or by calling the U.S. Department of Energy at (800) 423-1363.

EPA's *Green Vehicle Guide* providing information about the air pollution emissions and fuel economy performance of individual models is available on EPA's web site at:

http://www.epa.gov/greenvehicles/

For information about the Department of Transportation (DOT) Corporate Average Fuel Economy (CAFE) program, including a program overview, related rulemaking activities, research, and summaries of individual manufacturer's fuel economy performance since 1978, see:

http://www.nhtsa.dot.gov/ and click on "Fuel Economy"